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Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Research Document 86/17

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Comité scientifique consultatif des
pêches canadiennes dans l'Atlantique

CSCPCA Document de recherche 86/17

Status of the Atlantic Salmon of the LaHave River, Nova Scotia, in 1985 and Forecast of Returns in 1986

by

R.E. Cutting and E.M. Jefferson
Fisheries Research Branch
Dept. of Fisheries and Oceans
P.O. Box 550
Halifax, N.S.
B3J 2S7

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ABSTRACT

The LaHave River of southwestern Nova Scotia is an Atlantic Ocean coastal stream with Atlantic salmon spawning runs composed of more than eighty percent one-seawinter fish. A salmon development project initiated in 1968 has substantially increased natural production which has been reflected in increased recreational catches.

Spawning escapement estimate for 1985 suggests the egg deposition exceeded the 4.91 million egg requirement by about 169 percent, mainly due to escapement of an additional thousand multi-seawinter salmon. Spawning requirement was exceeded both above and below Morgan Falls.

Returns of combined hatchery-return and wild one-seawinter fish were below expectation, while river escapement of multi-seawinter salmon was higher than expected. The 1985 management plan had a favorable impact on the number of multi-seawinter salmon available for spawning.

Predictions of stock abundance in 1986 were made for several stock components and by different methods. Although the forecast for multi-seawinter fish shows a slight increase over 1985, the apparent weakness in the 1985 one-seawinter run does not augur well. Further, the one-seawinter return to the LaHave is expected to be 10-20 percent lower than in 1985.

RESUME

La rivière LaHave dans le sud-ouest de la Nouvelle-Ecosse est un cours d'eau côtier de l'Atlantique, dans lequel ont lieu des migrations de saumon de l'Atlantique durant la période du frai. Les bandes de saumons sont composées à plus de quatre-vingt pour cent de saumons ayant passé un hiver en mer. Un projet de développement des ressources en saumons initié en 1968 a permis d'augmenter substantiellement la production naturelle, et s'est traduit par un accroissement des prises de pêche sportive.

Les estimations de taux de survie du saumon au frai suggèrent que la ponte a dépassé d'environ 169 % le nombre requis de 4,91 millions d'oeufs, surtout en raison de la survie d'un millier additionnel de saumons de plusieurs années en mer. Le frai a dépassé l'abondance requise à la fois en amont et en aval de Morgan Falls.

Les chiffres combinés du produit de la pisciculture et de la pêche du saumon sauvage ayant passé un hiver en mer étaient plus bas, mais le taux de survie du saumon de plusieurs années en mer était plus haut que prévu. Le plan de gestion de 1985 a eu une incidence favorable sur le nombre de saumons de plusieurs années en mer pouvant frayer.

En 1986, on a fait un calcul théorique de l'abondance des peuplements, pour plusieurs composantes du peuplement et par différentes méthodes. Bien que les prévisions relatives au poisson de plusieurs années indiquent une légère augmentation par rapport à 1985, la faiblesse apparente du groupe de 1985 ayant passé un hiver en mer est un résultat peu favorable. De plus, on s'attend à ce que le nombre de saumons d'un an en mer retournant à LaHave soit inférieur de 10 à 20 % au chiffre de 1985.

103-02376/

INTRODUCTION

Description of the LaHave River drainage and its salmon stocks may be found in Cutting and Gray, MS 1984, and Cutting and Jefferson, MS 1985. Although the stock assessments have been vetted through the ACFF Subcommittee, no recommendations have been made by CAFSAC to the managers, due at least partly to the late timing of the prior assessment activity.

Management measures in 1985 incorporated most of those implemented in the 1984 management plan. Commercial salmon fishermen in both directed and interceptory fisheries accepted compensation in lieu of fishing. The angling season opened two weeks earlier, on May 10 rather than May 24 as in 1983 and 1984, but the July 31 closure date was retained. Anglers were prohibited from retaining fish larger than 62.9 cm. Moreover, the daily creel limit on the LaHave was one fish and released fish weren't counted toward that limit. Water levels were favorable for angling well into July, and anglers were generally pleased with the catch.

This document examines the status of the LaHave salmon stocks as experienced in 1985 and presents data and analyses relevant to that 1985 stock status and to the forecasts for 1986.

METHODS

Salmon Landings

Exploitation of LaHave stocks in 1985 occurred in the angling fishery[1], the distant commercial fishery and, minimally, as a by-catch in other fisheries gear (Table 1). The by-catch was prohibited by regulation but upwards of 200 fish may have been harvested in Zone 9 wherein the LaHave River is located.

Angling catch, and angler satisfaction, improved in 1985 over the 1984 level. The appearance of additional large salmon was particularly encouraging. Unfortunately, some anglers expressed their indignation at not being able to retain the large salmon by handling fish roughly during catch and release. Fish passing through the Morgan Falls counting facility in 1985 showed a marked increased in scaling and abrasions, as compared to fish appearances in prior years.

Biological Characteristics

Biological characteristics of the salmon stock have been obtained by sampling the adults at the Morgan Falls counting facility (Table 2).

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[1] Angling catches are available from two sources; the Conservation and Protection Branch, DFO, which is the traditional one, and the new license stub return system which is a cooperative project between DFO and the N.S. Dept. Lands and Forests. This assessment uses mainly the long-term data base available from the former source.

(1) Sex Ratios

Fish passing the counting facility are sexed by external examination. Past experience has indicated the need for correction of the sexing data for those fish entering the facility before August 1. The correction factors utilized to adjust the females were 1.15 and 0.88, for M-SW and 1-SW fish respectively. (Cutting and Gray, MS 1984).

(2) Size

All fish processed at Morgan Falls are weighed and measured for fork length. These data form the basis for the mean lengths and weights of the wild and hatchery-return components by sea age-class.

(3) Grilse/Salmon Ratios

Sea-age ratios were developed, based on the assumption that fish under 63.0 cm were grilse, i.e., 1SW salmon (Table 6). The wild grilse/salmon ratio in 1985 was 2.11:1 compared to the 1973-1983 pooled average of 5.4:1. Hatchery-return fish (1973-1984) have a pooled average ratio of 3.85:1. The 1984 and 1985 Management Plans have started shifting the ratio toward the salmon (MSW) component.

(4) Fecundity

Fecundity information for LaHave 1SW fish was collected in 1985. All fecundity information from these and MSW fish (53 fish ranging 52.0-95.3 cm FL, Table 5) was used to calculate the fecundity on fork length regression:

$$Fec = 468.08_e^{0.0353FL.}$$

This regression equation is similar to that for the Saint John River,

$Fec = 460.19_e^{0.03605FL.}$ Test on the regression coefficients showed no statistical difference ($t = 0.306$), meaning the samples came from one population.

(5) Spawning Requirements

A general spawner target of 2,815 1SW fish and 497 MSW fish was determined for the LaHave River (Cutting and Gray, MS 1984). The 1985 target of 1SW and MSW spawners was calculated by reflecting the mean sizes, sex ratios, and grilse/salmon ratio of both wild and hatchery-return fish in the run. The target number was that number required to meet a 2.4 eggs$\cdot m^{-2}$ deposition level for the 2,046,230 m^2 of rearing area.

Egg depositions were calculated using the estimated number of females in the 1SW and MSW sea age-classes multiplied by the fecundity value for the mean fork length. Separate calculations for wild and hatchery-return fish were summed.

1985 Escapement Estimates

The counting facility at Morgan Falls monitors fish movements for only the upper main river (Figure 1). Thus, estimates of escapement for the entire basin must be developed by construction. The 1985 escapement for the entire river was estimated by three methods.

Method I used angler exploitation rates for hatchery-return grilse and salmon, trap counts at Morgan Falls, angling catch statistics, and mean angler exploitation rates of wild grilse and salmon. Mean angler exploitation rates for hatchery-return salmon, based on recaptures of grilse and salmon which had been released as tagged hatchery-reared smolts and adjusted upward to account for 30 percent non-reporting, were 29.5 percent for 1 sea-winter compared to 24.7 percent for 2 sea-winter and older hatchery-return salmon. These exploitation rates were also used for wild stocks. Losses due to poaching and other mortalities were assumed to be 200 grilse and 100 salmon.

Method II used tag recapture data collected from grilse and salmon captured, tagged, and released from a trapnet located in the estuary of the LaHave River estuary in 1983 to estimate the proportion of the total LaHave stock represented by production above Morgan Falls. Since trap counts are available at Morgan Falls, estimates of total river escapement could be calculated. However, only a few, wild salmon, hatchery-return salmon and hatchery-return grilse were tagged, so only data from wild grilse were used in the analyses. Recapture rate was adjusted for an estimated 30 percent delayed mortality of tagged fish. From this analysis, 30.3 percent of the total escapement of wild grilse reached headwaters above Morgan Falls. In order to calculate wild salmon escapement, it was assumed that other parts of the LaHave River had the same grilse:salmon ratio as the fish at Morgan Falls. Poaching or losses and other mortalities are assumed the same as in Method I.

Method III for estimating wild escapements utilized data on rearing areas and known wild salmon production from the headwaters upstream from Morgan Falls as a proportion of total river nursery habitat. Egg deposition per m^2, juvenile production per rearing unit, and factors affecting survival are assumed to be similar throughout the river.

Prediction of 1986 escapement levels

Counts of MSW and 1SW salmon expected to return to the Morgan Falls counting facility in 1986 have been forecast on the basis of information collected at the facility during 1973-1983. MSW wild returns were estimated by two methods. Method A estimated the MSW returns from the significant correlation between the 1SW count in year t and the MSW count in year t + 1. Method B utilized the estimated mean return rate, measured by the number of MSW fish counted at Morgan Falls from the estimated eggs deposited in 1978 and 1979 (Table 8) applied to the estimated eggs deposited in 1981, to estimate the 1986 MSW returns.

The wild 1SW returns were estimated using Method B wherein the 1SW mean return rate from the 1978, 1979, 1980 and 1981 estimated egg depositions was applied to the 1982 estimated egg deposition to provide the 1986 1SW returns.

Returns of hatchery-reared 1SW and MSW salmon to Morgan Falls were estimated on the basis of mean rates of adult return of the estimated smolt outputs since 1976 when the Mersey Fish Culture Station assumed the LaHave River major stocking responsibility (Table 4).

If average angling conditions and no substantial change in angling season are assumed, an estimate of the 1986 angling catch can be made based on application of the estimated mean angling exploitation rates to the estimated returns of wild and hatchery-reared fish. A second estimate of the 1SW angling catch used the significant regression of total 1SW rod catch on total 1SW count at Morgan Falls.

RESULTS

1985 Egg Deposition Relative to Spawning Requirement

The spawning requirement is based on the quantity of spawning and rearing habitat, on fecundity, on sex ratios, on grilse/salmon ratios (Table 6), and on an assumed minimal egg deposition density of 2.4 eggs$\cdot m^{-2}$.

The target spawning escapement for 1985 was determined from these data:

LaHave River rearing area = 2,046,230 m^2 (Cutting and Gray, MS 1984)

Female salmon
(wild 2SW maiden) mean fork length = 71.1 cm

Female grilse
(wild 1SW maiden) mean fork length = 54.5 cm

Salmon sex ratio (wild M:F) = 0.10:0.90 (Table 6)
Grilse sex ratio (wild M:F) = 0.69:0.31 (Table 6)
Grilse/salmon ratio (wild) = 0.68:0.32 (Table 6)

The egg deposition per fish for 1985 is 2,237 eggs, as compared to 1,482 eggs in a calculation based on average stock values for 1973-1983. Thus, the required spawning requirement for the average situation, i.e., 3,312 fish, will necessarily decrease to 2,194 fish for 1985. At the 1985 wild grilse:salmon ratio, the numbers of grilse and salmon required to meet spawning requirements in 1985 are 1,492 and 702, respectively, for the 4.91 million egg deposition needed for the entire drainage.

The deposition requirement for the area above Morgan Falls is 1.65 million eggs. The egg deposition achieved in 1985 was about 4.26 million eggs, without correction for illicit removals or natural mortalities but with correction for broodstock removals from the Morgan Falls facility.

1985 Escapements

A comparison of the catches and counts observed in 1984 with the values forecast may prove useful.

	Hatchery return				Wild				Total			
	Obs.		For.		Obs.		For.		Obs.		For.	
	'84	'85	'84	'85	'84	'85	'84	'85	'84	'85	'84	'85
M. Falls count : 1SW	250	102	332	294	2043	1343	1963	2128	2293	1445	2295	2422
: MSW	36	77	8	57	384	638	238	436	420	715	246	493
Angling catch : 1SW	—	—	—	—	—	—	—	—	1481	1672*	1471	1230
: MSW	—	—	—	—	—	—	—	—	293	1038*	264	220
Commercial catch:MSW	—	—	—	—	—	—	—	—	82	0	140	82
River escapement**:MSW(w)	—	—	—	—	—	—	—	—	1088	1947	1188	1017

* Preliminary pending final angling catches; 1SW retained and MSW, released an additional 240 1SW were released. Improved angling conditions in the river in 1985 may have increased the angling exploitation for 1SW fish above average levels. Interestingly enough, of the MSW fish passing through the Morgan Falls facility, 24.3 percent showed signs of having been caught and released. This percentage compares favorably with the 24.7 percent mean angling exploitation rate offered in Table 7.

** Forecasts are made based on presence of a commercial salmon fishery. The fisheries management regulations designed to increase the escapement of MSW fish seem to be effective, relative to the forecasts of MSW fish.

The 1SW and MSW returns in 1985 calculated from Method I are summarized below.

Method I (1985)		1SW	MSW
River Escapement (W + HR)(Table 9)		3,835	2,061
Losses to commercial fisheries (Stat. Dist. 26-27)		0	0
Returns to homewaters	Total	3,835	2,060
All losses:			
commercial fishery (Table 1)		0	0
angling fishery (Table 1)		741	52[1]
poaching and other mortalities		200	100
	Total	941	152
Spawning escapement		2,894	1,908
Spawning requirements		1,492	702
Surplus or (deficit)		1,402	1,206

1 10% mortality of 517 MSW fish released.

Method II for estimating 1985 1SW and MSW returns uses recapture information from the estuarial trap net releases in 1983 as those tagged fish appeared at Morgan Falls.

Method II (1985)		1SW	MSW
River Escapement			
Salmon (W) (1,343/0.303; 4,432(638)/1,343		4,432	2,105
Salmon (W) angled (Table 9)		659	48*
Salmon (HR) angled (Table 9)		82	4*
Salmon (HR) Morgan Falls		102	77
	Total	5,275	2,234
Losses to commercial fisheries (Stat. Dist. 26-27)		0	0
Returns to homewaters	Total	5,275	2,234
All losses:			
Commercial salmon fishery		0	0
Non-salmon commercial gear		0	0
Angling fishery (footnote Method I)		741	52*
Poaching and other mortalities		200	100
	Total	941	152
Spawning escapement		4,534	2,082
Spawning requirements		1,492	702
Surplus or (deficit)		3,042	1,380

* 10 percent of catch as mortality

Method III used rearing area and known adult production above Morgan Falls to derive escapement.

Method III (1985)		1SW	MSW
River escapement			
Salmon (W)(1,343 x 2,046,228/685,732; 638 x 2,046,228/685,732)		4,008	1,904
Salmon (W + HR) angled (Table 1)		741	52*
Salmon (HR) Morgan Falls (Table 9)		102	77
Salmon (HR) Lower river		116	238
	Total	4,967	2,271
Losses to commercial fisheries (Stat. Dist. 26-27)		0	0
	Total	4,967	2,271
All losses:			
Commercial fisheries		0	0
Angling fishery (footnote Method I)		741	52*
Poaching and other mortalities		200	100
	Total	941	152
Spawning escapements		4,026	2,119
Spawning requirements		1,492	702
Surplus or (deficit)		2,534	1,417

* 10 percent of catch as mortality

1986 Forecast of Catches and Escapements

The count of MSW fish at Morgan Falls for 1986 was estimated by two methods.

Method A utilized the significant regression between wild 1SW counts in year t and the wild MSW counts in year t+1. That regression; $Y_{MSW} = 10.459 + 0.2412X_{1SW}$, $p < 0.01$, $r=0.906$, 1973-1985; estimates a 1986 wild MSW return to Morgan Falls of 334 fish (206-462, 95% C.L.). This return will be a mixture of 2SW and previous spawner fish. Alternatively a significant regression between wild 1SW counts in year t and the wild 2SW counts in year t+1; $Y_{2SW} = 7.4716 + 0.1842X_{1SW}$, $p < 0.01$, $r=0.836$, 1973-1985; estimates the 1986 2SW count will be 255 fish (146-362, 95% C.L.). A similar regression for hatchery-return MSW fish; $Y_{MSW} = -8.039 + 0.276X_{1SW}$, $p < 0.02$, $r=0.72$, 1973-1985 W/O 1983-84; estimates a 1986 MSW hatchery-return of 20 fish (0-109, 95% C.L.).

Method B utilized data in Table 8 for the method of determining egg deposition levels for above Morgan Falls, as has been described. Wild adult returns there can be tabulated according to their proper brood year. Because the 1985 fishing plan increased the spawning escapement of MSW fish, it was felt

preferable to use the mean 1978-1979 return rate, 0.011, multiplied by the estimated 4,862,500 eggs deposited in 1981 to provide an estimate of 535 wild MSW fish in 1986 for the circumstance where commercial and/or angling exploitation of MSW fish is permitted. In that circumstance where the limited fishing regime of 1985 is contined in 1986, use of the return rate from the 1980 egg deposition, i.e., 0.016 percent, would raise the estimated return of wild MSW salmon to 778 fish.

The count of wild 1SW fish at Morgan Falls is estimated on a similar basis by Method B. The return rate chosen for use is the mean rate observed for the 1978 to 1981 4-year period. The weighted mean (0.038 percent) estimates a return of 1,307 wild 1SW fish from the 3,412,600 eggs deposited in 1982. A further small number of fish are expected to arise as 3-year-old smolts from the 1981 eggs.

Returns of hatchery-reared 1SW and MSW salmon to the LaHave River in 1986 were estimated from the rates of return to Morgan Falls observed since 1976 from estimated smolt outputs (Table 4). Return rates have averaged as follows:

Smolt year-classes	Sea-age-class	Mean % return	Std. dev.	N
1976-1984	1SW	1.31	0.52	9
1976-1981,1983	MSW	0.26	0.15	7

Utilization of these rates estimates that 14 MSW fish will appear at Morgan Falls in 1986 from the 5,200 smolts arising from the smolts stocked in 1984 and 1985 above Morgan Falls. Additional hatchery-reared smolts below Morgan Falls (960 smolts from 12,000 fish stocked in 1984 and 16,050 smolts [64% of 29,752] from fish stocked in 1985) are estimated to return 287 (1.29x223) hatchery 1SW fish if their pattern of survival, migration, and removal is similar to that for fish returning above Morgan Falls. ABout 68 1SW fish are estimated at Morgan Falls from the 5,000 smolts in 1985. Smolts in 1984 stocked below Morgan Falls (9,600 smolts from 12,000 fish stocked in 1984 and 4,224 smolts from 52,803 stocked in 1983) are estimated to result in a further 45 (36x1.25) MSW fish below.

Presentation of a numerical forecast for the commercial catch of MSW fish in FSD's 26 and 27 is not possible. Although there is a significant correlation between the commercial MSW catch and the 1SW count at Morgan Falls in the prior year for 1973-1980, changes in the commercial fishing season and in the statistics reporting have invalidated the regression for the period since 1980.

River escapement of 1,326 (1,099-1,600, 95% C.L.) wild MSW fish is forecast on the basis of the ln-ln regression of the total MSW returns in year t+1 on total 1SW returns in year t (Table 9), $Log_{e_{MSW}} = -3.60003 + 1.31172 Log_{e_{1SW}}$, r=0.926, n=12, 1973-1985, p=0.00001 (Y converted from geometric mean to arithmetic mean per Ricker, 1975, p. 274-275).

Estimation of the 1SW angling catch in 1986 was determined from the regression of the total 1SW (HR + W) angling count on total 1SW (HR + W) counts at Morgan Falls in the same year. This regression; $Y_{ROD} = 445.94 + 0.4222X_{MF}$, r=0.66, n=13, 1972-1985, $p < 0.02$; estimates a 1SW rod catch of

1,026 (706-1,346, 95% C.L.) in 1986 from the estimated 1,375 1SW fish count forecast for Morgan Falls. Attainment of that catch (which is based on C&P statistics) will depend on average fishing effort in 1986 and on suitable climatic conditions for successful angling.

In summary, the numbers of LaHave fish counts and harvests estimated for 1986 are:

1986 Summary Forecast	1-SW	M-SW	1-SW	M-SW
River escapement (W)	6.289 million eggs x 0.038% x 1.29 (for angling correction)	1,326	3,458	1,326
(H)	(68 + 223)1.29	(14+45)1.25		
Losses to commercial fisheries			?	?
Returns to home waters			3,458	1,326
All homewater harvests and losses				
Commercial fishery			?	?
Angling fishery (M-SW:0.1 mortality of a 0.247 catch that is released)(C&P statistics)			1,026	33
Poaching and other mortalities			200	100
		Subtotal	1,226	133
Available spawning escapement			2,232	1,193
Requirement for spawners (on average)			-2,815	-497
Additional to spawning escapement			(-583)	696

Discussion

The egg requirement for the area above Morgan Falls is 1.65 million, at a deposition rate of 2.4 eggs$\cdot m^{-2}$. The threshhold has been exceeded beginning with 1978 (Table 8). The rates of adult return to Morgan Falls continue to decrease as the egg deposition has increased. Because the egg deposition which will provide the 1986 1SW returns was less that that for the 1985 returns, it will now prove interesting to see if the return rate in 1986 shows improvement over the lowest 0.028 percent rate seen in 1985.

The three methods of estimating the adequacy of the spawning escapement in 1985 suggest egg depositions continue to be more than sufficient (Table 9). The estimates are very sensitive to the angling exploitation rates utilized. These rates, in turn, rely on reasonably accurate angling catch estimates. The angling fishery in 1985 was unusual because suitable water conditions lasted almost the whole season, good numbers of fish came into the river, and some released fish

weren't counted against the bag limit. The different regulation regarding release of fish seems to have resulted in unusual impact on angling statistics. In the case of grilse, better anglers sometimes released smaller grilse in expectation that a larger grilse could be caught. In the case of the salmon, riverbank "talk" and observations strongly suggested some anglers were enhancing their alleged prowess by claiming to have released fish which were just pricked, or which were fought only briefly, or which were escaped grilse that were "willed" to have been salmon. If this attitude carried over onto the license stub returns, then the alleged salmon catch is substantially overstated. Two sources of information suggest the MSW salmon run was not inordinately large nor was the actual catch rate of salmon unusual. The salmon run to Morgan Falls was such that addition of the 1985 count to the regression of MSW count on 1SW count in the prior year improved the regression coefficient; thus the run was not outside the variation already documented. Second, the fish passing Morgan Falls were examined for evidence of having been caught by angling. Fish with evidence fell mainly into two groups, those with an obvious hook injury and with some scaling and those showing scaling only---a condition not seen in prior years. The percentages of the fish showing these evidences add to 24.3 percent, which compares quite well with the 24.7 percent angling rate derived from the tag returns (Table 7). In the case of the 1SW fish, examination of the Morgan Falls fish showed 6.9 percent had apparently been handled. Assuming a 29.5 percent angling exploitation rate for 1SW fish, the 6.9 percent translates to a release rate of 14.2 percent. The latter compares well with the 12.55 percent release rate reported in the first 38 percent of the license stub returns for the LaHave. The small difference can be because of inclusion of "jigged" fish in the count or because the relative production of 1SW fish is better above Morgan Falls than below Morgan Falls. Combining the caught and released components suggests a 1SW angling "exploitation" rate of 34.4 percent in 1985.

In summary, the river escapements of 1SW and MSW fish are not expected to exceed those occurring in 1985, with or without the commercial fishing option.

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TABLE 1. Commercial (District 26 and 27, incl. by-catch) and sport (wild and hatchery return)(DFO, C&P Br.) landings of 1SW and MSW salmon for the LaHave River, 1970-1985, in number of fish.

	Commercial			Sport					Total landings		
				Wild		Hatchery-return					
Year	1SW	MSW	Total	1SW	MSW	1SW	MSW	Total	1SW	MSW	Total
1970	29	209	238					650	586	302	888
1971	106	130	236					530	517	249	766
1972	151	154	305					399	457	247	704
1973	5	213	218	543	104	61	3	711	609	506	1,115
1974	50	194	244	720	85	130	7	942	900	286	1,186
1975	53	334	387	373	204	208	20	805	634	558	1,192
1976	188	514	702	795	81	217	29	1,122	1,200	624	1,824
1977	203	507	710	1,028	209	440	23	1,700	1,671	739	2,410
1978	119	464	583	71	111	104	56	342	294	631	925
1979	135	335	470	797	79	568	28	1,472	1,500	442	1,942
1980	205	969	1,174	1,195	428	78	92	1,793	1,478	1,489	2,967
1981	95	287	382	1,148	321	489	121	2,079	1,732	729	2,461
1982	90	161	251	525	115	260	65	965	875	341	1,216
1983	56	180	236	117	143	13	29	302	186	352	538
1984	145	82	227	442	115(23)	311	12(2)	880	898	209	1,107
1985*	0	0	0	659	481(481)	82	36(36)	1,258	741	517	1,258

* No commercial salmon fishery, by-catch is unknown under prohibition. Released fish in parentheses are included, but 10 percent mortality is assumed. In 1984, 111 grilse were caught in a special fall open season.

Angling catches from DFO-NSDL&F license stub system. Released fish in parentheses are included in catches.

Year	1SW	MSW	Total retained and released	
1983	289(28)	212(12)	501	
1984	1,481(142)	293(170)	1,774	
1985	1,859(205)	959(959)	2,818	(Preliminary)

TABLE 2. Stock origins and sea-age composition of salmon returns to the Morgan Falls fishway, 1970-1985.

	Hatchery		Wild		Total[1]		
Year	Grilse	Salmon	Grilse	Salmon	Grilse	Salmom	Combined
1970	--	--	2	4	2	4	6
1971	--	--	3	--	3	--	3
1972	9	--	8	2	17	2	19
1973	138	9	14	7	152	16	168
1974	442	19	29	2	471	21	492
1975	466	68	38	5	504	73	577
1976	468[2]	108	178[2]	23	646	131	777
1977	974	84[2]	292	25[2]	1,266	109	1,375
1978	567	209	275	67	842	276	1,118
1979	1,064	99	856	67	1,920	166	2,086
1980	336	489	1,637	288	1,973	777	2,750
1981	1,181	226	1,866	366	3,047	592	3,639
1982	621	230	799	256	1,420	486	1,906
1983	27	100	1,129	213	1,156	313	1,469
1984	250	36	2,043	384	2,293	420	2,713
1985	102	77	1,343	638	1,445	715	2,160

[1] Data are corrected for fallback movements.

[2] Hatchery return and wild returns in 1976 and 1977 were adjusted to credit the hatchery-reared fingerlings released in 1973 to the fish culture input.

TABLE 3. Number of hatchery-reared juvenile salmon released at different locations upstream from Morgan Falls, 1971-85 (1, 2).

Year of release	Juvenile Stage at Release						Total Release
	0+ Parr	1+ Parr		1+ Smolt		2+ Smolt	
		released	tagged	released	tagged	released	tagged	
1971		9,440		4,892	4,892			14,332
1972		6,790		8,400	8,400	6,450	5,000	21,640
1973	51,643[1]	43,133		9,166	4,970	18,526	7,971	122,468
1974		5,235		17,118	9,958	14,435	5,890	36,788
1975		18,883	13,963					18,883
1976		11,454		40,678	10,000	5,772	3,994	57,904
1977		28,183		95,204	20,000	7,371	4,000	130,758
1978		7,108		73,236	23,400			80,344
1979	30,000			33,910	8,000			63,910
1980	10,626[3]			63,226	9,995	16,026	5,996	89,878
1981				25,527	7,991			25,527
1982								0
1983				28,451	0			28,451
1984	33,000 fry			15,000	9,000			48,000
1985					4,995			4,995

[1] All hatchery-reared juvenile salmon had an excised adipose fin except underyearling parr (0+ and fry).

[2] Summarized from Gray and Cameron (1980).

[3] Released as unmarked fry from streamside incubator in late May 1980.

TABLE 4. Summary of distribution of hatchery-reared juvenile salmon above Morgan Falls in the LaHave RIver, number of 1SW and 2SW adult returns counted, and calculated return rates based on adult counts, 1976-1985.

Year of release	Juvenile stage	Number released	Estimated smolt output[1]	Adult returns to trap			Estimated return rate to trap (%)		
				1SW	2SW	Total	to 1SW	to 2SW	Total
1976	1+ Parr	11,454							
	1+ Smolt	40,678							
	2+ Smolt	5,772	45,867	974	158	1,132	2.12	0.34	2.46
1977	1+ Parr	28,183							
	1+ Smolt	95,204							
	2+ Smolt	7,371	91,370	567	50	617	0.62	0.05	0.68
1978	1+ Parr	7,108							
	1+ Smolt	73,236	77,478	1,064	385	1,449	1.37	0.50	1.87
1979	0+ Parr	30,000							
	1+ Smolt	33,910	35,830	336	116	452	0.94	0.32	1.26
1980	Fry	10,626							
	1+ Smolt	63,226							
	2+ Smolt	16,026	69,320	1,181	102	1,283	1.70	0.15	1.85
1981	1+ Smolt	25,527	32,680	621	64	685	1.90	0.20	2.10
1982	None	0	2,042	27	0	27	1.32	0	1.32
1983	1+ Smolt	28,451	22,761	250	63	313	1.10	0.28	1.38
1984	1+ Smolt	15,000	14,276	102	NA	NA	0.71	NA	NA
1985	1+ Smolt	4,996	5,200						
1986			400						

[1] Assumptions: 0+ parr to 1+ smolt survival is 60%; 1+ parr to 2+ smolt survival is 40%, 20% of 1+ smolts since 1976 do not migrate in year of stocking. Smolt output is the total of the age age 1+ and 2+ smolts that were estimated.

Mean return rates:	(1976-1983)	1.31	
	Std. dev.	0.52	
	(1976-1981, 1983)[2]		0.26
	Std. dev.		0.15

[2] Return rate for MSW fish in 1983 was not included in calculations of mean rate because of a very high proportion of previous spawners.

TABLE 5. Fork length-fecundity data* used to develop LaHave fecundity relationship.

Stock origin	Fork length (cm)	Fecundity
LaHave W	52.0	2,432
LaHave W	52.8	2,444
LaHave W	53.0	2,659
LaHave W	53.0	3,139
LaHave W	53.0	3,412
LaHave W	53.0	3,704
LaHave W	53.5	2,608
LaHave W	53.5	3,026
LaHave W	53.6	3,174
LaHave W	53.7	3,053
LaHave W	53.9	3,126
LaHave W	54.0	2,759
LaHave W	54.0	3,795
LaHave W	54.3	3,249
LaHave W	55.0	2,944
LaHave W	55.4	4,051
LaHave W	55.5	3,416
LaHave W	56.0	3,571
LaHave W	56.0	3,708
LaHave W	56.3	3,471
LaHave W	56.3	3,850
LaHave W	56.5	3,394
LaHave W	56.5	3,479
LaHave W	57.0	4,900
LaHave W	57.5	2,197
LaHave W	58.6	4,459
LaHave W	59.0	3,649
LaHave W	59.0	4,389
Medway HR	66.5	3,895
Medway W	68.1	4,160
Medway W	70.1	5,292
Medway W	71.1	5,404
Medway HR	72.1	5,025
LaHave HR	72.5	6,199
LaHave W	73.4	6,400
Medway HR	74.2	5,697
Medway W	74.7	7,527
LaHave W	75.0	7,198
Medway HR	75.7	7,456
Medway W	76.5	5,724
LaHave W	76.5	10,051
Medway W	76.7	6,324
Medway W	76.7	8,816
LaHave HR	76.8	7,767
LaHave HR	77.7	5,833
LaHave HR	78.3	8,129
Medway W	90.4	11,288
Medway W	90.9	13,760
LaHave HR	91.0	12,634
Medway W	91.7	11,220
LaHave W	92.5	12,657
Medway W	93.5	10,175
Medway W	95.3	13,020

* Data from Cutting and Gray (1984) and from 52.0-59.0 cm fish sampled in 1985.

TABLE 6. Sex ratio and salmon:grilse ratio of hatchery-return and wild Atlantic salmon recorded at the Morgan Falls trap, 1973-1985. Data are corrected for sexing error prior to July 31 each year.

	Hatchery returns						Wild					
	Salmon			Grilse			Salmon			Grilse		
Year	n	%F	%S	n	%F	%G	n	%F	%S	n	%F	%G
1973[2]	12	66	6	177	28	94	9	78	32	19	53	68
1974	25	76	7	314	24	93	2	---	5	40	27	95
1975	71	59	12	503	25	88	5	86	11	39	40	89
1976	104	64	17	523[1]	22	83	24	56	11	199	23	89
1977	83[1]	72	8	974	25	92	25	81	8	289	33	92
1978	208	79	27	553	30	73	67	66	20	275	34	80
1979	99	74	9	1,079	28	91	67	81	7	857	36	93
1980	515	59	61	335	26	39	287	69	15	1,618	29	85
1981	215	67	15	1,180	22	85	354	73	16	1,814	30	84
1982	230	77	27	627	30	73	258	71	25	793	24	75
1983	100	71	81	24	19	19	213	68	16	1,129	34	84
1984	36	83	13	250	16	87	384	69	16	2,043	30	84
1985[3]	77	96	42	102	30	58	638	90	32	1,343	31	68
Unweighted mean (S.D)		73(10.2)	25(23.2)		25(4.4)	75(23.2)		74(9.5)	16(8.8)		33(7.7)	84(8.8)

1 Data include 1SW salmon returns (1976) and 2SW returns (1977) from fall fingerlings released in 1973.

2 Data base from Cameron (in preparation).

3 No commercial salmon fishery in this year.

TABLE 7. Angling fishery exploitation rates of hatchery-return salmon derived from tag recaptures of hatchery-reared salmon released upstream from Morgan Falls as smolts. Exploitation rates in parentheses.

	TAG RECAPTURES							
	1-Sea-Winter				2-Sea-Winter & older			
Year of return	Angling Obs.	Angling Adj.*	Morgan Falls count	Total	Angling Obs.	Angling Adj.*	Morgan Falls count	Total
1977	40	57(0.311)	126	183				
1978	2	3(0.158)	16	19	7	10(0.213)	37	47
1979	13	19(0.345)	36	55				
1980	5	7(0.189)	30	37	5	7(0.152)	39	46
1981					6	9 (0.360)	16	25
1982	15	21(0.208)	80	101	9	13(0.406)	19	32
1983		0		2	3	4 (0.182)	18	22
1984	4	6(0.857)	1	7	0		2	2
1985	14	20(0.426)	27	47				
Mean		133(0.295)		451		43(0.247)		174

* Adjusted for 30 percent non-reporting.

TABLE 8. Egg deposition of wild and hatchery-return fish and resultant 1SW and MSW salmon returns to Morgan Falls, 1973-1985. Percent survival of eggs to observed adult returns in parentheses. Egg depositions are adjusted for broodstock removals for fish culture purposes or for transfers.

Year	Egg deposition (year t)	No. of wild salmon returns*		
		1SW (t+4)	MSW (t+5)	Total returns
1973	148,800	312 (0.210)	67 (0.045)	379 (0.255)
1974	395,600	332 (0.084)	71 (0.018)	403 (0.102)
1975	588,700	920 (0.156)	288 (0.049)	1,208 (0.205)
1976	898,500	1,634 (0.182)	353 (0.039)	1,987 (0.221)
1977	1,576,800	1,730 (0.110)	257 (0.016)	1,987 (0.126)
1978	1,840,300	832 (0.045)	210 (0.011)	1,042 (0.057)
1979	2,539,100	1,078 (0.042)	284 (0.011)	1,362 (0.053)
1980	3,990,300	1,950 (0.049)	628 (0.016)	2,578 (0.065)
1981	4,298,000	1,209 (0.028)		
1982	2,173,000			
1983	1,912,000			
1984	3,553,500			
1985	4,261,100			

* Data are adjusted to reflect freshwater age composition of the returns.

Table 9. Estimates of salmon in the wild river escapement, total river escapement, and egg depositions in the LaHave River, 1973-85.

	ANGLING FISHERY				MORGAN FALLS				RIVER ESCAPEMENT		TOTAL RIVER ESCAPEMENT			ESTIMATED EGG DEPOSITION[11] x 10[3]				
	Hatchery Return[1]		Wild[2]		Hatchery Return[3]		Wild[3]		Salmon (W)[4]		Salmon (HRW)[5]			Above M. Falls		Rest of Basin		
Year	Grilse	Salmon	Grilse	Salmon	Grilse	Salmon	Grilse	Salmon	Grilse	Salmon	Grilse	Salmon	Total	Grilse	Salmon	Grilse	Salmon	Total
(Column)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1973	58	4	546	103	138	9	14	7	1,851	417	2,047	430	2,477	112	36	2,146	1,455	3,749
1974	186	6	665	86	442	19	29	2	2,254	348	2,881	373	3,254	370	24	1,321	1,236	2,951
1975[6]	196	22	395	202	466	68	38	5	1,305(1,657)[9]	818	2,318	908	3,226	457	131	1,623	3,233	5,444
1976	196	35	816	75	468	108	178	23	2,766	304	3,430	447	3,877	723	175	1,294	700	2,892
1977[7]	418	28	1,060	204	974	84	292	25	3,593	826	4,975	938	5,913	1,308	252	2,281	2,938	6,779
1978[8]	65	69	110	98	567	209	275	67	373(949)[10]	397(1,151)[10]	1,581	1,429	3,010	843	813	583	4,123	6,362
1979	445	32	920	75	1,064	99	856	67	3,119	304	4,628	435	5,063	2,001	417	1,447	767	4,632
1980	141	160	1,132	360	336	439	1,637	288	3,837	1,457	4,314	2,106	6,420	1,827	1,849	979	3,412	8,067
1981	994	74	1,143	368	1,181	226	1,866	366	3,875	1,490	6,050	1,790	7,340	2,955	1,343	833	3,361	8,492
1982	260	75	525	105	621	230	799	256	1,780	425(1,242)[10]	2,661	1,547	4,208	1,341	832	342	3,774	6,289
1983	11	33	119	139	27	100	1,129	213	403(3,397)[9]	563	3,435	696	4,131	1,307	605	2,285	1,357	5,554
1984	265[12]	12	377	115	250	36	2,043	384	1,278(4,483)[9]	466(1,088)[10]	4,998	1,136	6,134	2,066	1,487	1,963	2,257	7,773
1985[13]	82[12]	36[12]	659	481	102	77	1,343	638	2,234(3,651)[9]	1,947	3,835[12]	2,060[12]	5,895	1,347	2,914	1,737	6,703	12,701

1. Based on yearly exploitation rates of hatchery grilse and salmon, or on mean exploitation rates of 0.295 and 0.247 for grilse and salmon respectively, Table 7.

   Thus: $\frac{\text{Fishway count HR Grilse}}{1.000-0.295}$ - Fishway counts HR Grilse = number of HR Grilse angled

2. Total annual angling catch of grilse minus Column 1 = Column 3 (wild grilse). Total annual angling catch of salmon minus Column 2 = Column 4 (wild salmon). Catches are Conservation and Protection Branch statistics for open season during the May 1-Sept. 9 period each year; these are not license stub return statistics.
3. Fish trap count at Morgan Falls.
4. Based on angling exploitations at 0.295 (1SW) and 0.247 (MSW) divided into angling catch = river escapement.
5. Total river escapement of grilse = Column 1+5+9 = Column 11; total river escapement of salmon = Column 2+6+10 = Column 12 (See footnote 12).
6. Low water conditions in July, Aug., and Sept. adversely influenced 1SW angling catch but not MSW salmon catch in June.
7. Failure of the 1977 smolt year-class; low water conditions in June, July, Aug., Sept. adversely influenced 1SW and MSW angling catches in 1978.
8. Failure of the 1977 smolt year-class adversely affected the MSW returns in 1979.
9. Estimated from regression $Y_{MF\ count1SW} = 1.98\ X_{1SW\ angling} - 849.72$ (1973-'77, 1979-'82), minus HR grilse in Column 1, ÷ 0.295.
10. Estimated from mean ratios of grilse (time t) to salmon (t+1) (1973-1982) of 3.121G:1S.
11. Egg deposition : Grilse (Columns 14 and 16) and Salmon (Colums 15 and 17); annual mean fork length in $Fec.=468.08e^{0.0353FL}$ times ♀ F times no. of fish.
    Estimated deposition from broodstock collections has been removed. No adjustment for instream losses to poaching or mortalities. Morgan Falls counts determine numbers of spawners there. Lower basin grilse = Columns 11 - (1+3+5+7). Lower basin salmon = Columns 12 - (2+4+6+8).
12. The HR component was enhanced by fish which returned from smolts stocked below Morgan Falls in 1983 and 1984, if their performance was similar to the groups stocked above Morgan Falls.
13. Angled MSW fish were released for spawning with 10 percent mortality.

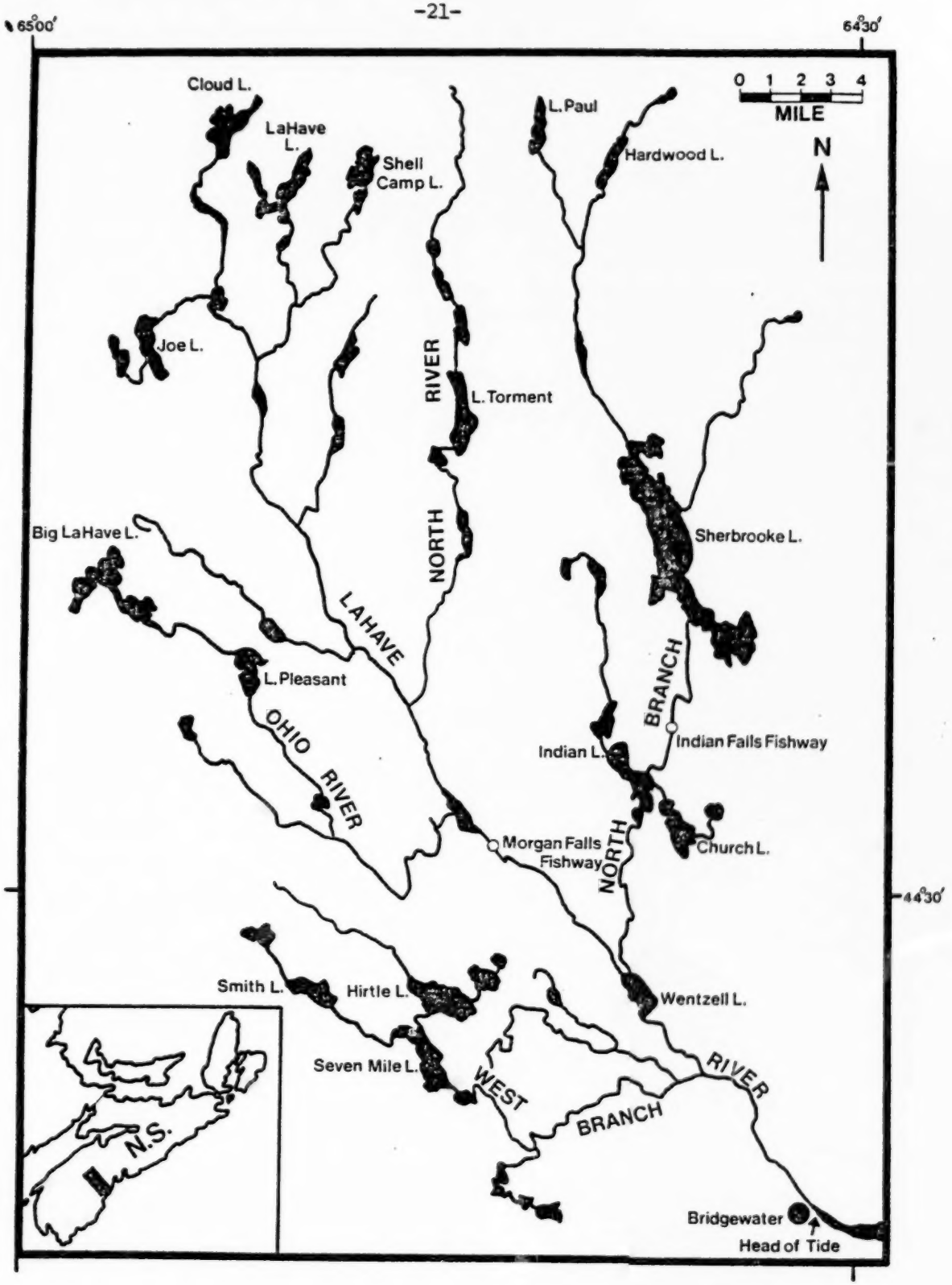

Fig. 1. The LaHave River drainage, Nova Scotia.